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OPTICAL SYSTEM FOR HEAT-HOMING BOMB

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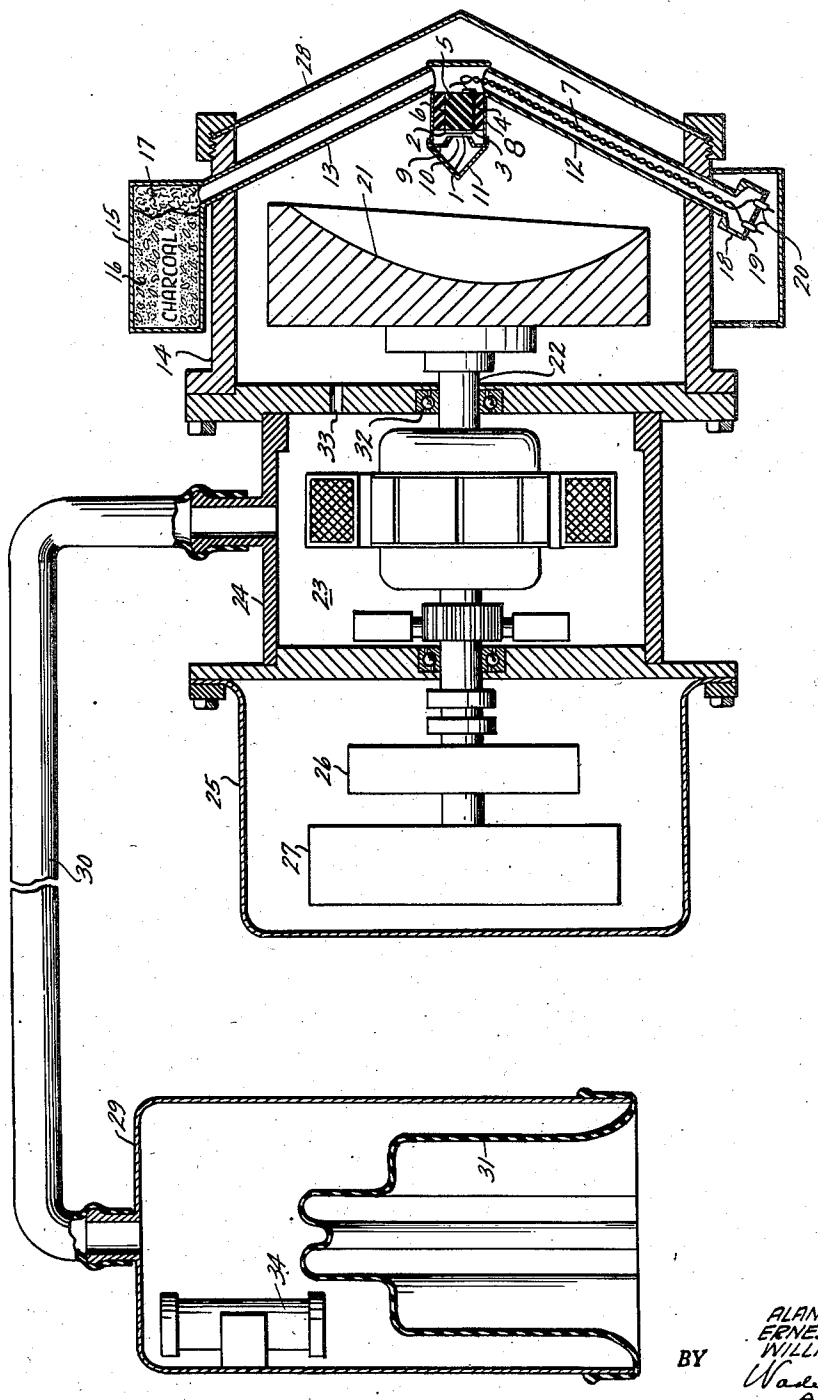

INVENTORS.
ALAN C. BEMIS
ERNEST B. DANE JR.
WILLARD E. BUCK
BY Wade Kooney
ATTORNEY
James S. Shannon
AGENT

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OPTICAL SYSTEM FOR HEAT-HOMING BOMB

Alan C. Bemis, Concord, Mass., Willard E. Buck, Inyokern, Calif., and Ernest B. Dane, Jr., Belmont, Mass., assignors to United States of America as represented by the Secretary of War

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3 Claims. (Cl. 250—83)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without payment to us of any royalty thereon.

This invention relates to the optical system of a heat-homing bomb and is directed particularly to means for protecting the optical system from the effects of the varying atmospheric conditions to which the bomb is subjected in flight.

Bombs of this type may be carried in the bomb bays of standard bombers and are usually dropped with the aid of a bombsight in the same manner as a freely falling bomb. The control system is usually operative only during the last fifteen seconds or so of the bomb's fall and serves to steer the bomb toward the strongest source of infra-red radiation in the field of view of the bomb's optical system.

The optical system is located in the nose of the bomb and comprises an infra-red sensitive receiver and a suitable scanning device which enables the receiver to scan an area of size consistent with the maneuverability of the bomb. The bomb is steered by angularly displacing its axis with respect to its velocity vector, the resulting "lift" produced by the body of the bomb being sufficient to change its direction of travel. The displacement of the bomb's axis is accomplished by rudder and elevator surfaces located in the tail of the bomb and controlled by means of servomotors, which are in turn controlled by an electronic unit capable of interpreting the information received from the optical system. The bomb is stabilized with respect to roll by gyroscopically controlled aileron surfaces also located in the tail.

In a bomb which is to descend rapidly from cold temperatures aloft to warm moist surface layers, it is a very difficult problem to avoid moisture condensation on the optical surfaces. Since water is opaque at the infra-red wave-length used, even small quantities of condensation can not be tolerated. It is therefore the object of the invention to provide means for protecting the optical surfaces from moisture condensation without seriously reducing the sensitivity of the optical system. This is accomplished by enclosing the optical system in a gas tight container having means for drying the air inside and having a window made of material highly transparent to infra-red radiations and sufficiently thin to stay in equilibrium with the temperature of the air flowing over its outer surface. In order to avoid crushing of the thin window by changes in atmospheric pressure during the fall of the bomb, a pressure equalizing device is provided for maintaining the pressure inside the container substantially the same as that outside the container without the introduction of moist air.

The drawing shows a cross-sectional view of the optical system and pressure equalizing apparatus.

Referring to the figure, the bolometer or infra-red sensitive element comprises several thin nickel strips **1** supported side by side in a plane perpendicular to the paper by spring strips of conductive material **2** and **3**. These spring strips exert a tension on the nickel strips so as to keep them tight, and also serve to connect the nickel strips electrically in series. The spring strips are clamped between blocks of insulating material **4**, **5** and **6** which hold them in position. Two leads **7** are provided for connection to the spring strips located at the two ends of the series connection of nickel strips. One lead is shown connected while the strip to which the other lead connects is cut away by the sectional view. The nickel strips are coated with a black heat absorbing substance so that when infra-red radiations fall thereon, the temperature and therefore the resistance of the series combination is changed.

The bolometer is enclosed in a cylindrical metallic housing **8**, the inward end of which is closed by a silver diaphragm **9** having a circular aperture **10** in its center. The diaphragm is soldered to the casing **8** and a conical window **11** of silver chloride is fused to diaphragm **9** making a gas tight closure for the end of cylinder **8**. The window is made conical in shape in order to avoid reflections from the bolometer back to itself. Advantages of silver chloride for window material are its high transparency to infra-red radiations, the ease with which it can be machined and rolled or pressed into almost any desired form, and the readiness with which it can be fused to silver or glass. An article on silver chloride windows may be found in the Review of Scientific Instruments, vol. 13, No. 8, 335–337, August 1942, entitled "The Preparation of Silver Chloride Films" by Fugassi, Paul, and McKinney.

The cylinder **8** is closed at its outer end and supported by two metallic tubes **12** and **13** which are fitted into holes near the outer end and soldered thereto to make gas tight joints. The tubes **12** and **13** are supported at their other ends by the housing **14**. Tube **13** terminates in a gas trap filled with carbon particles **16** held in place by glass wool **17**. Tube **12** terminates in a flared portion **18** covered by a plate **19** through which leads **7** are brought by means of glass beads **20**. The gas tight container thus formed for the bolometer is filled with hydrogen at a pressure of about 4 mm. of mercury, the trap **15** acting to absorb any other extraneous gases.

The housing **14** also contains a parabolic mirror **21** rotatably mounted on shaft **22**. The mirror is so mounted that its optical axis is at an angle of about 5 degrees with its axis of rotation. The bolometer is positioned so that the point of intersection of the optical axis and the axis of rotation falls on the sensitive elements **1** of the bolometer in the center of the area under the aperture **10**. The diameter of aperture **10** is such as to subtend an angle at the optical center of the mirror which is twice that between the optical axis and the axis of rotation, or about 10 degrees. With this arrangement, the bolometer sees a circular area 10 degrees in diameter in a plane perpendicular to the axis of rotation. As the mirror revolves this area revolves about the axis of rotation thus scanning an area 20 degrees in diameter.

The mirror **21** is rotated at a constant speed of about 32 revolutions per second by constant speed direct current motor **23** inclosed in housing **24**. Following housing **24** is an additional housing **25** containing speed regulating device **26** for motor **23** and commutating device **27**. The commutating device is part of the electronic control circuit used to interpret the signals received from the bolometer. Since elements **26** and **27** do not form part of the invention, the details of their construction are not given. The joints between housings **24** and **25** and between **24** and **14** are made gas tight.

The outer end of housing **14** is made gas tight by means of the large window **28**. Like the small window **11**, this window is made of silver chloride and is conical in shape for strength and to avoid reflections. In order to avoid the condensation of moisture on the outer surface of

window **28**, it is necessary to keep its temperature substantially equal to that of the air flowing over its outer surface. In order for the window temperature to follow that of the outer air, it is necessary that it be made very thin. Tests indicate that a silver chloride window 0.4 mm. thick will not lag more than one or two seconds behind equilibrium with its surroundings during a drop from high altitude.

To prevent crushing of the thin window **28** by changes in atmospheric pressure, it is necessary to provide means for equalizing the pressures on the two sides of the window. This is accomplished by pressure equalizing chamber **29** which is connected to the housing **24** by means of hose **30**. The open end of chamber **29** is covered with an airtight flexible diaphragm **31**. The pressure in housing **24** is kept the same as that in housing **14** by leakage through the bearing **32**, and, if necessary, through an additional opening **33**. The flexible diaphragm permits the pressure in housing **14** to assume the same value as the outside pressure without the introduction of moist air which would cause condensation on the surface of mirror **21** and the surface of window **11**. In order to dry the air inside the housing of the optical system, a container **34** filled with a suitable desiccant may be employed.

What I claim is:

1. In an optical system for a heat-homing bomb comprising an infra-red sensitive device inclosed in a gas-tight housing having a window transparent to infra-red radiations and a mirror for focusing infra-red radiations

on said sensitive device through said window, means for preventing the condensation of moisture on said mirror and window comprising means forming a gas-tight enclosure containing said mirror and window, said gas-tight enclosure comprising a second window made of material having high transparency to infra-red radiations for admitting infra-red radiations to said mirror, said second window being sufficiently thin to remain substantially in temperature equilibrium with the surrounding air whereby condensation of moisture thereon is prevented, means positioned so as to be accessible to the air inside said enclosure and containing a desiccating agent for drying the air inside said enclosure, and means including a flexible gas-tight diaphragm positioned so as to form a gas-tight closure for an opening to the inside of said enclosure for maintaining the pressures on each side of said second window substantially equal without the introduction of moist air.

2. Apparatus as claimed in claim 1 in which said second window is made of fused silver chloride.

3. Apparatus as claimed in claim 1 in which said second window is made of fused silver chloride and is conical in shape to increase its strength and reduce reflections.

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